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Land Use and Precipitation Affect Organic and Microbial Carbon Stocks and the Specific Metabolic Quotient in Soils of Eleven Ecosystems of Mt. Kilimanjaro, Tanzania

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Abstract

© 2016 John Wiley & Sons, Ltd.Tropical ecosystems are under increasing pressure of land-use changes, strongly affecting the carbon cycle. Conversion from natural to agri-cultural ecosystems is often accompanied by a decrease in the stocks of organic and microbial carbon (Corg, Cmic) as well as changes in microbial activity and litter decomposition. Eleven ecosystems along an elevation gradient on the slopes of Mt. Kilimanjaro were used to investigate impacts of land-use changes on Corg and Cmic stocks as well as the specific metabolic respiration quotient (qsCO2) in surface soils. Six natural, two semi-natural and three intensively used agricultural ecosystems were investigated on an elevation gradient from 950 to 3,880masl. To estimate the effects of precipitation, rainfall regimes of 3·6 and 20·0mm were simulated. Corg stocks were controlled by water availability, temperature and net primary production. Agricultural management resulted in decreases of Corg and Cmic stocks by 38% and 76%, respectively. In addition, agricultural systems were characterized by low Cmic:Corg ratios, indicating a decline in available substrate. Enhanced land-use intensity leads to increased qsCO2 (agricultural>semi-natural>natural). The traditional homegardens stood out as a sustainable land-use form with high substrate availability and microbial efficiency. Soil CO2 efflux and qsCO2 generally increased with precipitation level. We conclude that soils of Mt. Kilimanjaro's ecosystems are highly sensitive to land-use changes and are vulnerable to changes in precipitation, especially at low elevations. Even though qsCO2 was measured under different water contents, it can be used as an indicator of ecosystem disturbances caused by land-use and management practices.

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Keywords

C :C mic org, Elevation, Land use, Precipitation, Soil microbes, Soil respiration